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Impact of transplanting dates and nitrogen levels on the incidence and severity of rice diseases

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Abstract
Field experiments were conducted during *kharif* 2016, 2017 and 2018 to ascertain the effect of transplanting dates and nitrogen levels on the incidence and severity of rice diseases. The pooled results showed that rice seedlings transplanted on 2nd and 4th week of July recorded minimum sheath rot intensity of 12.63 and 12.06 percent respectively and whereas, minimum bacterial blight disease intensity, 16.96 per cent was observed when rice seedlings transplanted on 4th week of July. However, seedlings transplanted in 2nd week of August recorded maximum sheath rot incidence (26.22%), sheath rot intensity (20.98%) and bacterial blight disease intensity (33.21%). In case of discolor grains, the crop transplanted during 4th week of July registered lower (6.74%) per cent of discolored grains and were significantly superior over 2nd week of August transplanting date (10.29%). The increase rate of nitrogen levels from 80 to 100 to 120 kg/ha is directly proportional with increase disease intensity. The maximum grain yield (3070 kg/ha) and straw yield (4640 kg/ha) were obtained during 4th week July transplanted seedlings, whereas minimum grain and straw yield was noticed when seedlings were transplanted in 2nd week of August. Moreover, the maximum grain and straw yield 2994 kg/ha and 4468 kg/ha, respectively was recorded in treatment plots fertilized with 100 kg N/ ha.

Keywords: Rice, transplanting date, nitrogen level, sheath rot, grain discolouration, bacterial blight

Introduction

In Gujarat, rice occupies about 5% (6.5 to 7.0 lakh ha.) of the gross cropped area of the state and accounts for around 14% of the total food grain production (9.0 to 10.5 lakh tones) (Mehta *et al*. 2010) [9]. In the quest for increasing rice production, peoples have resorted to intensive methods of cultivation by utilizing high-yielding cultivars, higher plant population per unit area and high doses of nitrogenous fertilizers which intensified the attack of several pests and diseases from its seeding to harvesting. Several biotic and abiotic factors are the main constraint for reducing the production and productivity of rice. Among the biotic factors, diseases (26%), insects (20%) and weeds (23%) are affecting large amount of yield loss, both in terms of quality and quantity. Among the different diseases of rice, brown leaf spot (*Helminthosporium oryzae*), blast (*Pyricularia grisea*), sheath blight (*Rhizoctonia solani*), sheath rot (*Sarocladium oryzae*), bacterial leaf blight (*Xanthomonas oryzae* pv. *oryzae*), rice tungro virus (Virus), false smut (*Ustilaginoidea virens*), leaf scald (*Rhynchosoprium oryzae*), bakanae disease (*Fusarium moniliforme*), grain discoloration (*Drechslera oryzae*, *Fusarium* spp.) are more prevalent (Mustafa *et al*., 2013) [10]. Among all the diseases that have an impact on rice growth, bacterial leaf blight, blast, grain discoloration and sheath rot are recognized as one of the most devastating diseases resulting in severe yield losses especially in Gujarat state (Mehta *et al*. 2012). Luong *et al*., 2003 [7] conducted two seasons experimental trials and showed that nitrogen fertilizer did not affect rice growth only, but also more impacted to the outbreak of insect pests and diseases, more nitrogen application was forced more occurrence of diseases. Malav and Ramani, 2015 [8] reported that the intensity of various diseases was influenced by different levels of N and Si in rice during the crop growth period, increased levels of N alone increased the intensity of diseases (leaf blight, brown spot and grain discoloration). Pal *et al*., 2016 [12], concluded that in an early sown rice crop there was maximum sheath blight of rice disease severity (39.85%) and disease incidence (35.36%). In order to achieve an effective and sustainable control of the rice diseases, a management strategy integrating the use of resistant cultivar, appropriate planting date, and appropriate nitrogen levels must be developed. Therefore, the present study is undertaken on rice variety GR – 11 to study the influence of two main cultural practices *viz*; date of transplanting and nitrogen fertilizer on the disease incidence and severity.

Material and Methods

A field experiment was conducted on rice variety GR-11 at College of Agriculture and Anand Agricultural University, Vaso District Kheda (Gujarat) of Middle Gujarat, Zone III during *Kharif* season for three consecutive years of 2017, 2018 and 2019. The seeds were planted according to the specified dates and approximately thirty days old seedlings of rice were transplanted on at D_1 – 2nd week of July, D_2 – 4th week of July, D_3 - 2nd week of August and three levels of nitrogen were applied as N_1: 80 kg N/ha, N_2: 100 kg N/ha and N_3: 120 kg N/ha. The experiment was laid in a split plot design with three replications. The effective plot size was 5.40 m × 3.60 m giving 19.44 m^2 by adopting spacing of 20 x 15 cm. The nitrogen was applied through urea as per treatments in split doses as; 40% N as basal, 40% N at tillering stage and 20% N at panicle initiation stage. The other agronomical practices were followed as per the recommendations except plant protection measures.

The of sheath rot disease incidence was recorded by counting number of affected panicles from randomly selected five hills in each net plot area at fortnightly interval after initiation of disease till to the harvest of the crop. The percent incidence of sheath rot disease was then determined the by using the following formula;

$$\text{Disease incidence (\%)} = \frac{\text{Total no. of rice plants assessed}}{\text{Total no. infected plants}} \times 100$$

The diseased severity was assessed by observing diseased plants in a given plot and assigning severity score (0 – 9) as per standard evaluation system (SES) to each observation. Based on the score, percentage of leaf sheath/lesion area covered by the particular disease was assessed by using formula. For which, physiologically active leaves/sheath in each tiller of a hill were observed at fortnightly interval after initiation of disease till to the harvest of crop and for assessing the severity of the particular disease five hills in each net plot area were randomly selected.

Moreover, the number of healthy and discoloured grains were counted from each treatment by selecting ten ear heads at random and the percentage of grain discolouration was calculated. After harvesting the grain and straw yield were separately recorded as kg/plot and then convert it into kg/ha. The data so obtained were statistically analyzed using ANOVA and t-test to ascertain the effectiveness of the treatments.

$$\text{Disease severity (\%)} = \frac{\text{Sum of all numerical ratings}}{\text{No. of observations} \times \text{maximum rating scale}} \times 100$$

Table 1: Standard Evaluation System (SES) Scale (1996) to asses sheath rot disease affected tillers

Score	Description
0	No incidence
1	Less than 1%
3	1-5%
5	6-25%
7	26-50%
9	51-100%

Table 1: Standard Evaluation System (SES) Scale (1996) to asses bacterial leaf blight affected leaves

Score	Description (affected lesion area)
1	1-5%
3	6-12%
5	13-25%
7	26-50%
9	51-100%

Results

Sheath rot disease incidence

Effect of transplanting date

The data (Table 1) on sheath rot disease incidence recorded during individual year as well as pooled indicated that the incidence of sheath rot was recorded significantly lower in paddy transplanted during 2nd week of July (D_1) as well as during 4th week of July (D_2) over the crop transplanted during 2nd week of August (D_3). During the first year (2017), lower (18.67%) per cent of sheath rot disease incidence was observed in paddy transplanted during 4th week of July (D_2), however, it was found at par with the crop transplanted during 2nd week of July (D_1). However, in the second-year minimum sheath rot disease intensity (11.72%) was observed in 2nd week of July (D_1) transplanting date and was at par with 4th week of July (D_2) and both were significantly superior over 2nd week of August (D_3) transplanting date recorded maximum (19.22%) sheath rot incidence. The sheath rot disease incidence in third year revealed that, crop transplanted during 4th week of July (D_2) registered the lowest (11.96%) sheath rot disease incidence. The pooled data computed for three years revealed that both the date of transplanting *i.e.* 4th week of July and 2nd week of July exhibited 14.69% to 16.32% sheath rot disease incidence and remained at par with each other over the D_3 transplanting date *i.e.* 2nd week of August (26.22%).

Effect of nitrogen level

The results on effect of different nitrogen levels on sheath rot incidence was found non-significant during individual as well as pooled over years (Table 1).

Interaction effect

Interaction effect of different transplanting dates and nitrogen levels were found non-significant with respect to sheath rot disease incidence.

Sheath rot disease intensity

Effect of transplanting date

The effect of different dates of transplanting (Table 1) on intensity of sheath rot disease indicated that crop transplanted during 4th week of July (D_2) registered the lowest (15.86%) per cent of sheath rot disease intensity, which remained at par with D_1 (2nd week of July) transplanting date (19.41%) and were significantly superior over 2nd week of August (D_3) transplanting date recorded maximum (28.90%). However, during the second year, crop transplanted in 2nd week of July (D_1) recorded lower (8.96%) per cent of sheath rot disease intensity and it was found at par with the treatment D_2 (11.25%). The treatment of last date transplanting observed with highest (16.40%) per cent of sheath rot disease intensity than aforesaid treatments. The data recorded during third year exhibited similar trend as recorded during the first year of experiment. The data on pooled over years indicated that the transplanting date D_2 (4th week of July) observed with lower (12.06%) per cent of sheath rot disease intensity. While, the crop transplanted during 2nd week of July (D_1) remained at par with D_2 (12.63%) and both were significantly superior over 2nd week of August (D_3) transplanting date recorded maximum (19.22%) sheath rot intensity. Thus, the transplanting dates showed significant effect on disease incidence

Effect of nitrogen level

There was no significant effect of different nitrogen level on sheath rot intensity as data were non-significant (Table 1).

Interaction effect

Interaction effect of different date of transplanting and dose of nitrogen was found non-significant with respect to sheath rot disease intensity.

Discolor grains

Effect of transplanting date

In case of discolor grains, the data of first year (Table 2) indicated that paddy transplanted during 4th week of July (D_2) registered lower (7.92%) per cent of discolored grains, however, it was found at par with D_1 (8.78%). The highest per cent of discolor grains was observed in the treatment of last date of transplanting (13.78%). While, during second and third year of experimentation, all the dates of transplanting remained at par with each other with non-significant difference. The result of pooled over years showed that among the different treatments, the crop transplanted during 4th week of July (D_2) registered lower (6.74%) per cent of discolored grains was found at par with D_1 (7.03%) and significantly superior over 2nd week of August (D_3) transplanting date (10.29%).

Effects of nitrogen level

The results on effect of different level of nitrogen on discolored grains was found non-significant during individual as well as pooled over years (Table 2).

Interaction effect

Interaction effect of different date of transplanting and dose of nitrogen was found non-significant with respect to discoloration of grains (Table 2).

Bacterial blight intensity

Effect of transplanting date

Data (Table 3) indicated that lower (18.67%) per cent of bacterial blight disease intensity was observed in crop transplanted during 4th week of July (D_2), and was found at par with the treatment of 2nd week of July (24.38%) transplanted paddy during the first year (2017). Whereas, during the second year (2018), the plots transplanted during 2nd week of July (D1) registered lower (12.61%) per cent bacterial blight intensity. More or less, likewise first year similar trend was observed during the third year (2019). The data on pooled over years indicated that the transplanting date 4th week of July (D_2) observed with lower (16.96%) per cent of bacterial blight intensity. While, the crop transplanted during 2nd week of July (D_1) remained at par with D_2 (19.04%) and were significantly superior over 2nd week of August (D_3) transplanting date recorded maximum 30.00 per cent bacterial blight intensity.

Effect of nitrogen level

There was no significant effect of different level of nitrogen on bacterial blight intensity as the data were non-significant (Table 3) during first, second and third year. However, the data on pooled over years was found significant and revealed that the crop transplanted during 2nd week of July (D_1) registered lower (20.03%) per cent of bacterial blight intensity over rest of the treatments.

Interaction effect

Interaction effect of different date of transplanting and dose of nitrogen was found non-significant with respect to on bacterial blight intensity.

Grain yield

Effect of transplanting date on grain yield

Yield data (Table 4) recorded for individual year as well as pooled indicated that significantly maximum grain yield was recorded in paddy transplanted in 4th week of July (2985 kg/ha) over the rest of the treatments during the first year (2017). However, the crop transplanted during 2nd week of July (D_1) registered 2812 kg/ha grain yield. During the second year (2018), higher (3041 kg/ha) grain yield was harvested from the plot transplanted during 2nd week of July (D_1) and it was found at par with next date of transplanting *i.e.* 4th week of July with 2884 kg/ha of grain. Moreover, the data in the third year indicated that the treatment of paddy transplanted during the 4th week of July registered higher (3342 kg/ha) grain yield and it was at par with former date of transplanting *i.e.* 2nd week of July (3120 kg/ha). The pooled data over the years showed that significantly the highest grain yield; 3070 kg/ha and 2991 kg/ha was recorded from the plots transplanted during 4th week of July (D_2) and 2nd week of July (D_1), respectively and were significantly superior over the paddy transplanted during 2nd week of August (2235 kg/ha).

Effect of nitrogen level on grain yield

There was no significant effect of different level of nitrogen on grain yield as the data were non-significant (Table 4) during second and third year. However, the data on pooled over years indicated that the crop transplanted during 4th week of July (D_2) registered higher (2994 kg/ha) grain yield over rest of the treatments except D_1 (2725 kg/ha).

Interaction effect

Interaction effect of different date of transplanting and dose of nitrogen was found non-significant with respect to grain yield.

Straw yield

Effect of transplanting date on straw yield

Straw yield data (Table 4) recorded for the first year indicated that paddy transplanted during 4th week of July registered higher (4365 kg/ha) straw yield than paddy transplanted during 2nd week of August (3642 kg/ha). However, during the second year, crop transplanted during 2nd week of July observed with higher (4722 kg/ha) and it was found at par with next date of transplanting *i.e.* 4th week of July (4572 kg/ha). Whereas, during the third year as well as pooled data of straw yield indicated that the crop transplanted during 4th week of July (D2) produced higher (4982 and 4640 kg/ha) straw yield and it was remained at par with former date of transplanting *i.e.* 2nd week of July with 4783 and 4555 kg/ha, respectively.

Effect of nitrogen level on straw yield

There was no significant effect of different level of nitrogen on straw yield as the data were non-significant (Table 4).

Interaction effect

Interaction effect of different date of transplanting and dose of nitrogen was found non-significant with respect to straw yield.

Discussion

Thus, the late date of transplanting D3 - 2nd week of August recorded maximum significant disease incidence and severity of sheath rot, grain discolouration and intensity of bacterial leaf blight than the early transplanted seedlings during second (D1) and fourth week (D3) of July. This could have been as a result of weather factors like low temperature and higher relatively humidity that favour the disease development. This is in accordance with the report of Naklang *et al*. (1996) [11] and Laory *et al*. (2012) [6], who observed that planting rice after the optimum date can result in higher disease and insect incidence. This is also in agreement with the report of Ahonsi *et al*. (2000) [1], who observed that planting date significantly affected disease incidence. They reported that rice sown with early rain was virtually free from disease, while those sown when the rain has fully established or at the peak were the most infected with fungi disease. Dubey (2004) [2], reported that leaf, node and neck blast infection were minimum in early June sown rice and their infection increase gradually in crops sown at later dates. The transplanting of rice seedlings in second week of July to minimize the incidence of diseases are in accordance with Pal *et al*. who reported the minimum rice blast disease incidence when the crop was sown on 15th July (normal sowing).

Our data conclusively show that high amounts of nitrogen (180 kg/ha) application is directly proportional to increase in sheath rot and bacterial blight disease incidence than lower level of N application (80 and 120 kg/ha). Sridhar (1972) [14] reported that increases in susceptibility to leaf blast occurred in both highly and moderately susceptible cultivars. Similarly, Malav and Ramani (2015) [8] mention that disease intensity was significantly influenced by the different N and Si level combinations and observed that increased levels of N alone increased the intensity of diseases *viz*., leaf blight, brown spot and grain discoloration.

The results of rice grain and straw yield showed a significant effect of planting date the highest grain (3070 kg/ha) and straw yield (44640 kg/ha) was obtained in 4th week of July (D2) transplanting, followed by 2nd week of July (D1), while the least grain yield 2235 kg/ha occurred in 2nd week of August (D3). These results are in concurrence with Ehsanullah *et al.* (2007) [3], according to them late transplanting date in rice decreases grain yield. This is also in support of the report of Vandana *et al.* (1994) [15], who observed that with delaying in planting, harvesting index would be decreased.

Conclusion

Rice seedlings transplanted on 2nd and 4th week of July with application of nitrogen at 80 kg N/ ha and 100 kg N/ ha recorded minimum sheath rot and bacterial blight disease intensity as compared to rice seedlings transplanted during 2nd week of August and application of nitrogenous fertilizer at 120 kg/ ha. The maximum grain and straw yield were obtained higher in 2nd and 4th week transplanted rice seedling as well as plots fertilized with 100 kg N/ ha and 80 kg N/ ha.

Table 1: Effect of transplanting date and nitrogen levels on sheath rot disease incidence and intensity (Pooled over years)

Treatments	Sheath rot disease incidence (%)				Sheath rot disease intensity (%)			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled
Date of Transplanting (D)								
D_1	28.28 (22.45)	20.02 (11.72)	23.20 (15.52)	23.83 (16.32)	26.14 (19.41)	17.42 (8.96)	18.89 (10.48)	20.82 (12.63)
D_2	25.60 (18.67)	21.81 (13.80)	20.23 (11.96)	22.54 (14.69)	23.47 (15.86)	19.60 (11.25)	17.90 (9.45)	20.32 (12.06)
D_3	39.93 (38.19)	26.00 (19.22)	28.21 (22.34)	30.80 (26.22)	32.52 (28.90)	23.89 (16.40)	25.36 (18.34)	27.26 (20.98)
S.Em. ±	1.09	0.69	0.75	1.33	1.27	0.57	0.82	0.54
C.D. at 5%	4.27	2.70	2.93	5.20	4.99	2.23	3.22	1.66
C.V. (%)	10.64	9.11	9.39	10.02	13.93	8.38	11.87	12.28
Nitrogen level (N)								
N_1	30.14 (25.21)	21.84 (13.84)	22.74 (14.94)	24.91 (17.74)	26.87 (20.43)	19.42 (11.05)	19.64 (11.30)	21.98 (14.01)
N_2	30.41 (25.62)	22.38 (14.50)	23.78 (16.26)	25.52 (18.56)	27.34 (21.09)	20.14 (11.86)	20.63 (12.41)	22.70 (14.89)
N_3	31.51 (27.32)	23.62 (16.05)	25.12 (18.02)	26.75 (20.26)	27.92 (21.92)	21.35 (13.25)	21.89 (13.90)	23.72 (16.18)
S.Em. ±	0.96	0.87	0.87	0.52	1.39	0.79	0.74	0.59
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS
C.V. (%)	9.39	11.50	10.97	10.51	15.18	11.66	10.72	13.36
Interaction								
D_1N_1	28.30 (22.48)	19.34 (10.97)	22.42 (14.55)	23.35 (15.71)	25.80 (18.94)	16.50 (8.07)	17.83 (9.38)	20.04 (11.74)
D_1N_2	27.93 (21.94)	19.97 (11.66)	23.09 (15.38)	23.66 (16.10)	26.14 (19.41)	17.31 (8.85)	18.52 (10.09)	20.66 (12.45)
D_1N_3	28.60 (22.91)	20.76 (12.56)	24.09 (16.66)	24.48 (17.17)	26.47 (19.87)	18.45 (10.02)	20.32 (12.06)	21.74 (13.72)
D_2N_1	24.66 (17.41)	21.19 (13.07)	18.91 (10.50)	21.59 (13.54)	23.11 (15.41)	18.99 (10.59)	16.99 (8.54)	19.70 (11.36)
D_2N_2	25.43 (18.44)	21.48 (13.41)	20.07 (11.78)	22.33 (14.44)	23.57 (15.99)	19.38 (11.01)	18.20 (9.76)	20.38 (12.13)
D_2N_3	26.70 (20.19)	22.76 (14.97)	21.70 (13.67)	23.72 (16.18)	23.72 (16.18)	20.43 (12.18)	18.50 (10.07)	20.88 (12.70)
D_3N_1	37.47 (37.01)	24.98 (17.83)	26.89 (20.46)	29.78 (24.67)	31.70 (27.61)	22.78 (14.99)	24.08 (16.65)	26.19 (19.48)
D_3N_2	37.87 (37.68)	25.68 (18.78)	28.17 (22.29)	30.57 (25.87)	32.29 (28.54)	23.72 (16.18)	25.16 (18.08)	27.06 (20.70)
D_3N_3	39.22 (39.98)	27.33 (21.08)	29.56 (24.34)	32.04 (28.14)	33.56 (30.56)	25.16 (18.08)	26.85 (20.40)	28.52 (22.80)
	S.Em. ± / C.D. at 5%	S.Em. ± / C.D. at 5%	S.Em. ± / C.D. at 5%	S.Em. ± / C.D. at 5%	S.Em. ± / C.D. at 5%	S.Em. ± / C.D. at 5%	S.Em. ± / C.D. at 5%	S.Em. ± / C.D. at 5%
Y	- / -	- / -	- / -	0.50 / 1.53	- / -	- / -	- / -	0.54 / 1.66

Y x D	-	-	-	-	-	-	0.86	2.70	-	-	-	-	-	-	0.93	NS
Y x N	-	-	-	-	-	-	0.90	NS	-	-	-	-	-	-	1.02	NS
D x N	1.66	NS	1.50	NS	1.51	NS	0.90	NS	2.40	NS	1.37	NS	1.28	NS	1.02	NS
Y x D x N	-	-	-	-	-	-	1.56	NS	-	-	-	-	-	-	1.76	NS
C.V. (%)	9.39		11.50		10.97		10.51		15.18		11.66		10.72		13.36	

Note: Figures outside the parenthesis are arcsine transformed values, those inside are retransformed values.

Table 2: Effect of transplanting date and nitrogen levels on discolored grains due to sheath rot disease of rice (Pooled over years)

Treatments	**Discolored grains (%)**							
	2017		**2018**		**2019**		**Pooled**	
Date of Transplanting (D)								
D_1	17.24 (08.78)		17.19 (08.73)		11.70 (04.11)		15.38 (07.03)	
D_2	16.34 (07.92)		17.58 (09.12)		11.23 (03.79)		15.05 (06.74)	
D_3	21.79 (13.78)		21.11 (12.97)		13.23 (05.24)		18.71 (10.29)	
S.Em. ±	0.59		0.95		0.61		0.43	
C.D. at 5%	2.32		NS		NS		1.31	
C.V. (%)	9.62		15.36		15.10		13.49	
Nitrogen level (N)								
N_1	18.14 (09.69)		18.28 (09.84)		12.21 (04.47)		16.21 (07.79)	
N_2	18.52 (10.09)		18.43 (09.99)		11.61 (04.05)		16.20 (07.78)	
N_3	18.72 (10.30)		19.17 (10.78)		12.30 (04.54)		16.73 (08.29)	
S.Em. ±	0.64		0.97		0.59		0.43	
C.D. at 5%	NS		NS		NS		NS	
C.V. (%)	10.38		15.54		14.64		13.73	
Interaction (D x N)								
D_1N_1	17.32 (08.86)		17.00 (08.55)		11.89 (04.24)		15.40 (07.05)	
D_1N_2	17.00 (08.55)		16.95 (08.50)		11.47 (03.95)		15.14 (06.82)	
D_1N_3	17.40 (08.94)		17.62 (09.16)		11.74 (04.14)		15.59 (07.22)	
D_2N_1	15.98 (07.58)		17.38 (08.92)		11.47 (03.95)		14.94 (06.65)	
D_2N_2	16.40 (07.97)		17.29 (08.83)		10.76 (03.49)		14.82 (06.54)	
D_2N_3	16.65 (08.21)		18.07 (09.62)		11.47 (03.95)		15.40 (07.05)	
D_3N_1	21.12 (12.98)		20.45 (12.21)		13.26 (05.26)		18.28 (09.84)	
D_3N_2	22.16 (14.23)		21.04 (12.89)		12.74 (04.86)		18.65 (10.23)	
D_3N_3	22.10 (14.15)		21.83 (13.83)		13.68 (05.59)		19.20 (10.82)	
	S.Em. ±	C.D. at 5%	S.Em. ±	C.D. at 5%	S.Em. ±	C.D. at 5%	S.Em. ±	C.D. at 5%
Y	-	-	-	-	-	-	0.43	1.31
Y x D	-	-	-	-	-	-	0.74	NS
Y x N	-	-	-	-	-	-	0.75	NS
D x N	1.11	NS	1.67	NS	1.02	NS	0.75	NS
Y x D x N	-	-	-	-	-	-	1.29	NS
C.V. (%)	10.38		15.54		14.64		13.73	

Note: Figures outside the parenthesis are arcsine transformed values, those inside are retransformed values.

Table 3: Effect of transplanting date and nitrogen levels on bacterial blight disease intensity of rice (Pooled over years)

Treatments	**Bacterial blight disease intensity (%)**			
	2017	**2018**	**2019**	**Pooled**
Date of Transplanting (D)				
D_1	29.59 (24.38)	20.80 (12.61)	27.22 (20.92)	25.87 (19.04)
D_2	25.60 (18.67)	23.55 (15.96)	23.80 (16.28)	24.32 (16.96)
D_3	36.59 (35.53)	28.38 (22.59)	34.66 (32.34)	33.21 (30.00)
S.Em. ±	1.51	0.88	0.65	1.21
C.D. at 5%	5.91	3.46	2.53	4.76
C.V. (%)	14.77	10.90	6.77	11.59
Nitrogen level (N)				
N_1	29.12 (23.68)	23.31 (15.66)	27.34 (21.09)	26.59 (20.03)
N_2	30.23 (25.35)	24.07 (16.63)	28.29 (22.46)	27.53 (21.36)
N_3	32.43 (28.76)	25.35 (22.59)	30.05 (25.08)	29.28 (23.92)
S.Em. ±	1.40	1.09	1.01	0.68
C.D. at 5%	NS	NS	NS	1.96
C.V. (%)	13.77	13.47	10.63	12.74
Interaction				
D_1N_1	27.94 (21.95)	20.01 (11.71)	26.07 (19.31)	24.68 (17.43)
D_1N_2	29.23 (23.85)	20.46 (12.22)	27.03 (20.65)	25.57 (18.63)
D_1N_3	31.60 (27.46)	21.92 (13.94)	28.56 (22.86)	27.36 (21.12)
D_2N_1	24.71 (17.47)	22.51 (14.66)	22.65 (14.83)	23.29 (15.63)
D_2N_2	25.36 (18.34)	23.42 (15.80)	23.61 (16.04)	24.13 (16.71)

D_2N_3	26.72 (20.22)		24.72 (17.49)		25.13 (18.03)		25.52 (18.56)	
D_3N_1	34.70 (32.41)		27.40 (21.18)		33.31 (30.16)		31.80 (27.77)	
D_3N_2	36.09 (34.70)		28.33 (22.52)		34.21 (31.61)		32.88 (29.47)	
D_3N_3	38.97 (39.55)		29.42 (24.13)		36.46 (35.31)		34.95 (32.82)	
	S. Em ±	C.D. at 5%	S. Em ±	C.D. at 5%	S. Em ±	C.D. at 5%	S. Em ±	C.D. at 5%
Y	-	-	-	-	-	-	0.62	1.91
Y x D	-	-	-	-	-	-	1.07	3.31
Y x N	-	-	-	-	-	-	1.18	NS
D x N	2.43	NS	1.89	NS	1.75	NS	1.18	NS
Y x D x N	-	-	-	-	-	-	2.04	NS
C.V. (%)	13.77		13.47		10.63		12.74	

Note: Figures outside the parenthesis are arcsine transformed values, those inside are retransformed values

Table 4: Effect of transplanting dates and nitrogen levels on grain and straw yield of rice (Pooled over years)

Treatments	Grain yield (kg/ha)								Straw yield (kg/ha)							
	2017		2018		2019		Pooled		2017		2018		2019		Pooled	
Date of Transplanting (D)																
D_1	2812		3041		3120		2991		4160		4722		4783		4555	
D_2	2985		2884		3342		3070		4365		4572		4982		4640	
D_3	2139		2217		2350		2235		3642		3775		3865		3761	
S.Em. ±	109		136		111		69		53.88		128		225		88	
C.D. at 5%	427		535		437		213		212		503		881		272	
C.V. (%)	12.35		15.07		11.38		12.96		3.99		8.82		14.83		10.59	
Nitrogen level (N)																
N_1	2603		2691		2880		2725		4023		4380		4523		4309	
N_2	2992		2900		3089		2994		4173		4602		4627		4468	
N_3	2341		2550		2843		2578		3971		4086		4479		4179	
S.Em. ±	156		204		124		95.10		225		194		419		171	
C.D. at 5%	480		NS		NS		273		NS		NS		NS		NS	
C.V. (%)	17.67		22.56		12.71		17.87		16.67		13.33		27.68		20.60	
Interaction (D x N)																
D_1N_1	2641		2970		3033		2881		3928		4767		4739		4478	
D_1N_2	3350		3258		3354		3320		4354		5014		4924		4764	
D_1N_3	2447		2896		2974		2772		4199		4385		4685		4423	
D_2N_1	2906		2923		3242		3024		4338		4575		4804		4572	
D_2N_2	3321		2984		3413		3239		4469		4861		5127		4819	
D_2N_3	2727		2745		3372		2948		4289		4279		5014		4528	
D_3N_1	2261		2181		2365		2269		3803		3799		4026		3876	
D_3N_2	2306		2459		2500		2421		3697		3932		3830		3819	
D_3N_3	1848		2010		2184		2014		3425		3595		3738		3586	
	SEm ±	CD at 5%	SEm ±	CD at 5%	SEm ±	CD at 5%	SEm ±	CD at 5%	SEm ±	CD at 5%	SEm ±	CD at 5%	SEm ±	CD at 5%	SEm ±	CD at 5%
Y	-	-	-	-	-	-	69	213	-	-	-	-	-	-	88	271
Y x D	-	-	-	-	-	-	120	NS	-	-	-	-	-	-	152	NS
Y x N	-	-	-	-	-	-	165	NS	-	-	-	-	-	-	297	NS
D x N	270	NS	353	NS	216	NS	165	NS	390	NS	335	NS	726	NS	297	NS
Y x D x N	-	-	-	-	-	-	285	NS	-	-	-	-	-	-	514	NS
CV (%)	17.67		22.56		12.71		17.87		16.67		13.33		27.68		18.61	

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